NIST Evaluation of Latent Fingerprint Algorithms

(A proposal)

Michael Garris, Vladimir Dvornychenko, & Austin Hicklin

Current Applications (Front End)

1. Latent Image Search
   - Originating agency submits a latent image
   - Features are encoded automatically by machine
   - Machine Encoding
2. Latent Feature Search
   - Originating agency submits latent features encoded by a fingerprint examiner
   - Human Encoding

Current Applications (Back End)

1. Latent Search of Tenprints
   - Match latent to a background of tenprints

     (E.g. Crime scene identification)
2. Tenprint Search of Latents
   - Match tenprint to a background of latents

     (E.g. Searching the Unsolved Latent File)
3. Latent Search of Latents

Simple Objectives

Front End

- How good is machine encoding?
- Benefits of machine encoding?

Back End

- How good is automated match determination?
- Benefits of automated match determination?

What we have to work with

Latents

- Images
- Feature set
  - Human encoded
  - Machine encoded

Tenprints (Mates & Non-Mates)

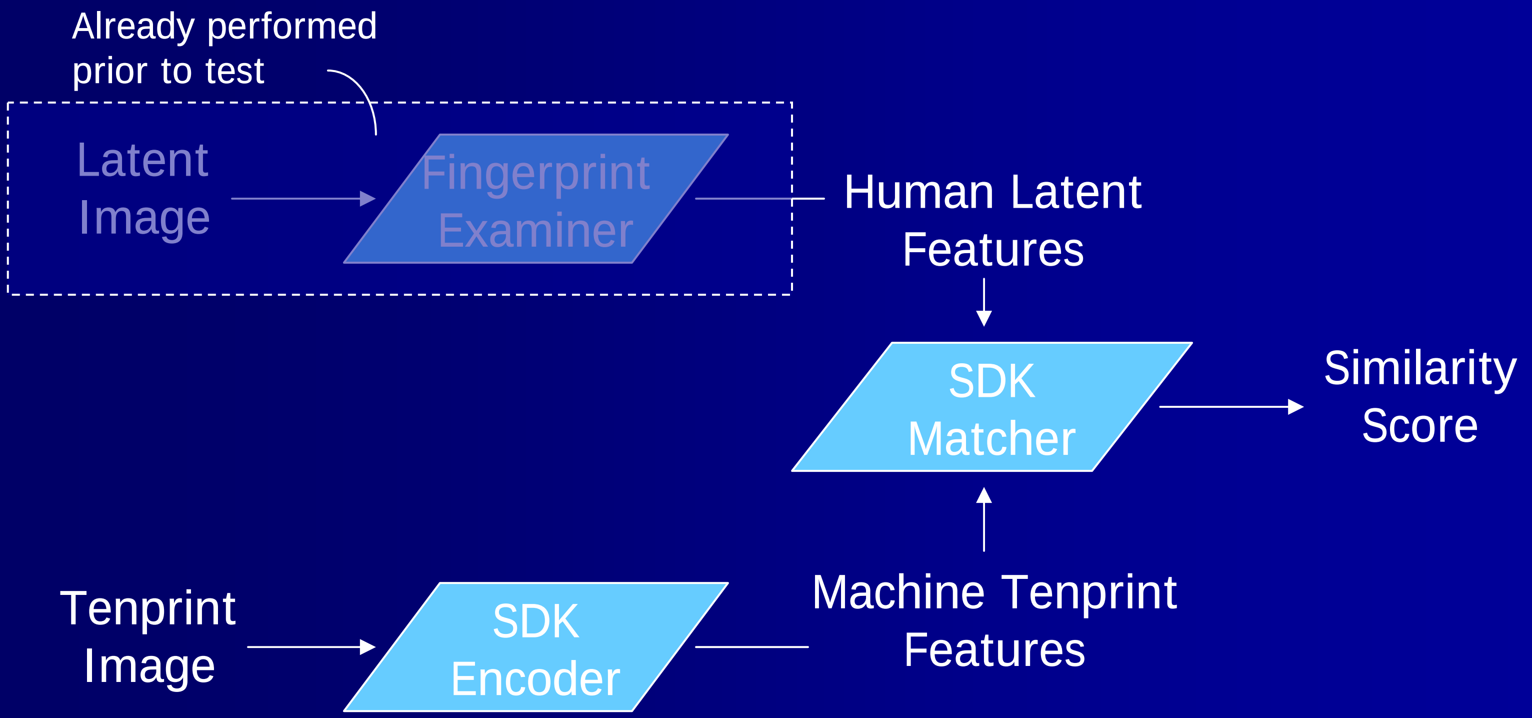
- Images
- Feature set
  - Machine encoded

SDK Testing
(Subroutine and API for the following)

1. Encoder
   - IN: Latent or Tenprint image
   - OUT: Feature Template
2. Matcher
   - IN: 2 Feature Templates
   - OUT: Similarity Score
3. Score Normalization
   - IN: Vector of Scores
     (all scores for latent against gallery of tenprints)
   - OUT: Normalized Vector of Scores

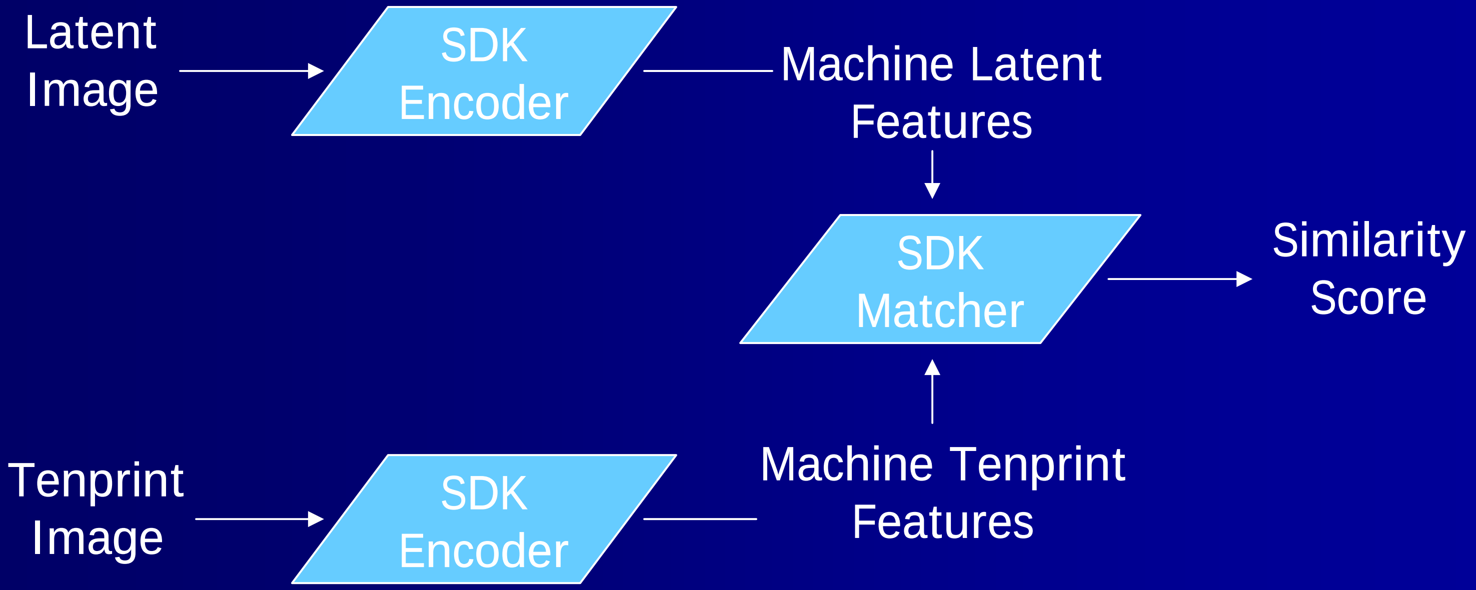
Front End Scenario 1

Human Latent Encoding



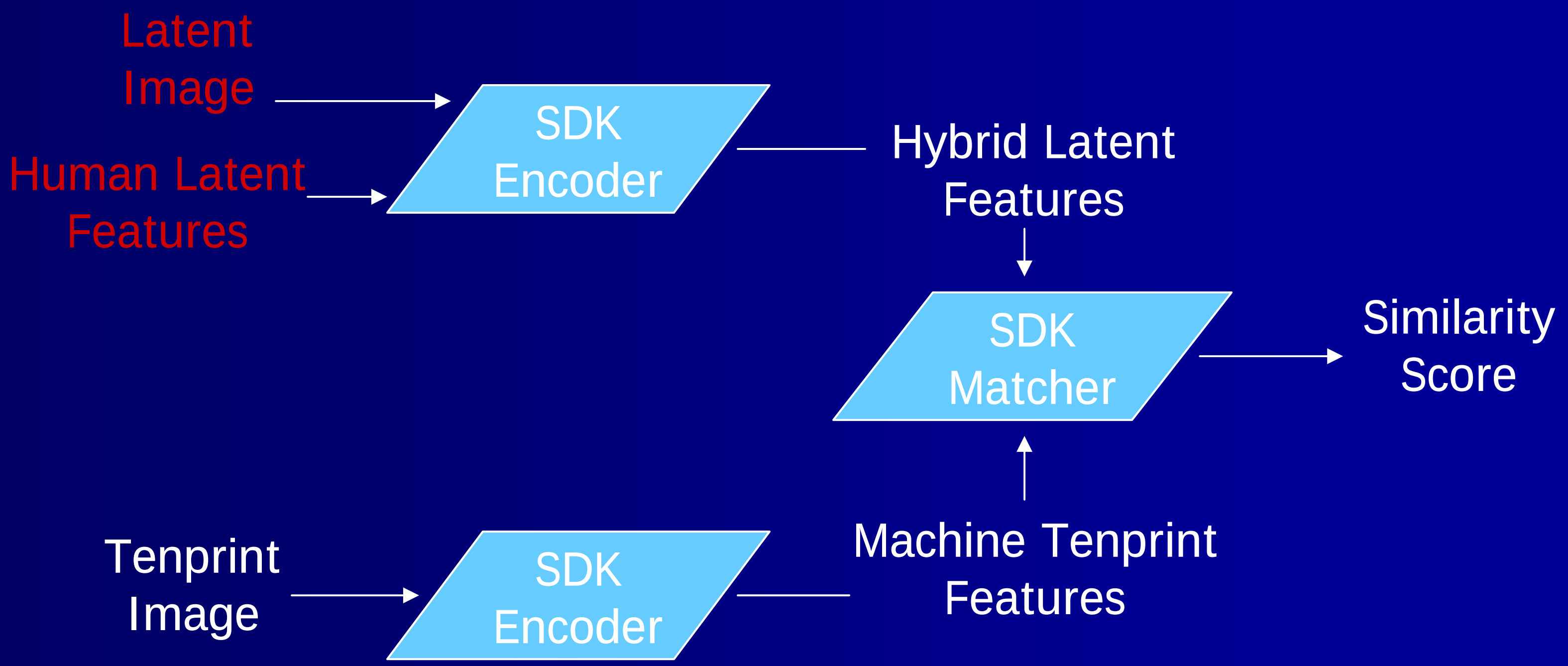
Front End Scenario 2

Machine Latent Encoding

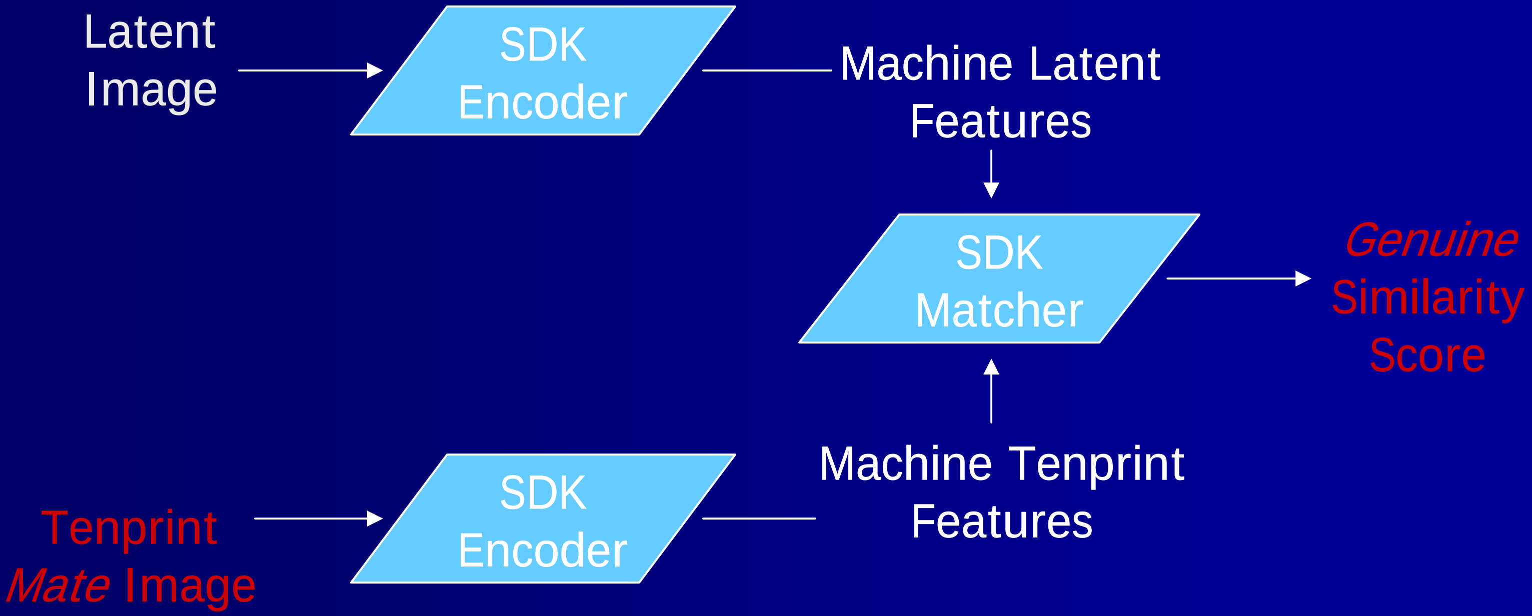


Front End Scenario 3

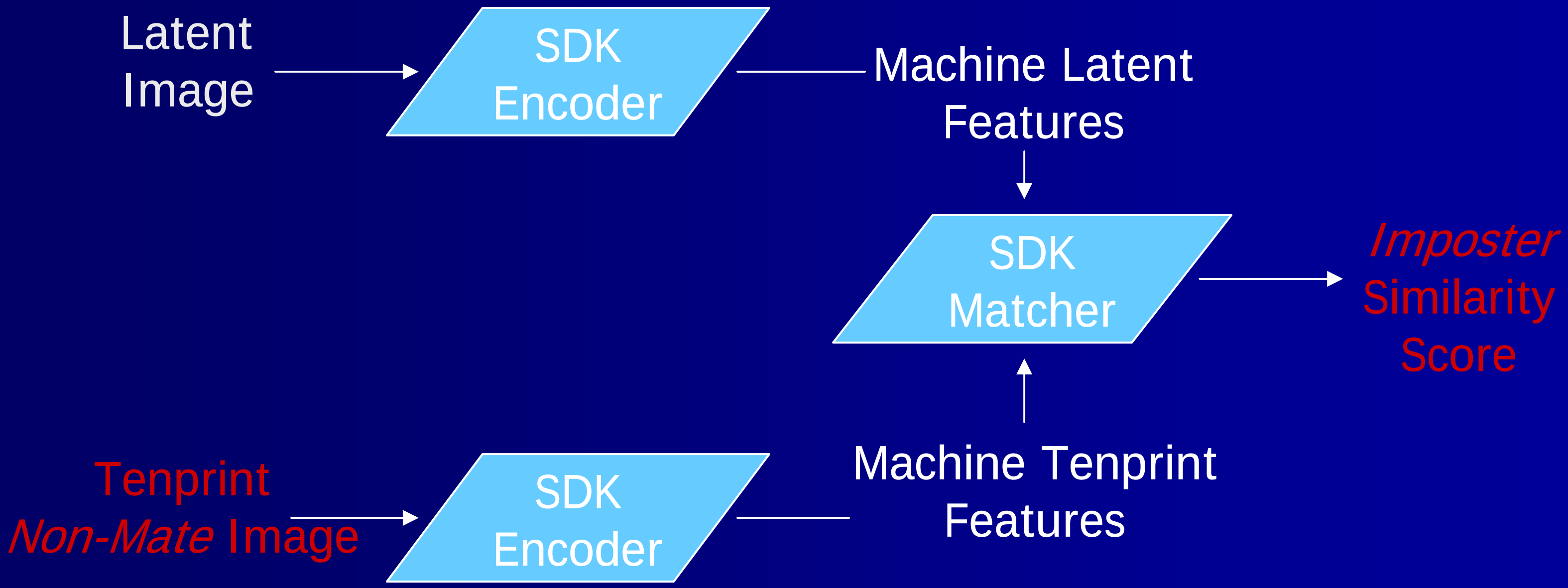
Hybrid Latent Encoding



Back End Scenario



Back End Scenario



Latent Image

SDK Encoder

Machine Latent Features

SDK Matcher

Imposter Similarity Score

Tenprint *Non-Mate* Image

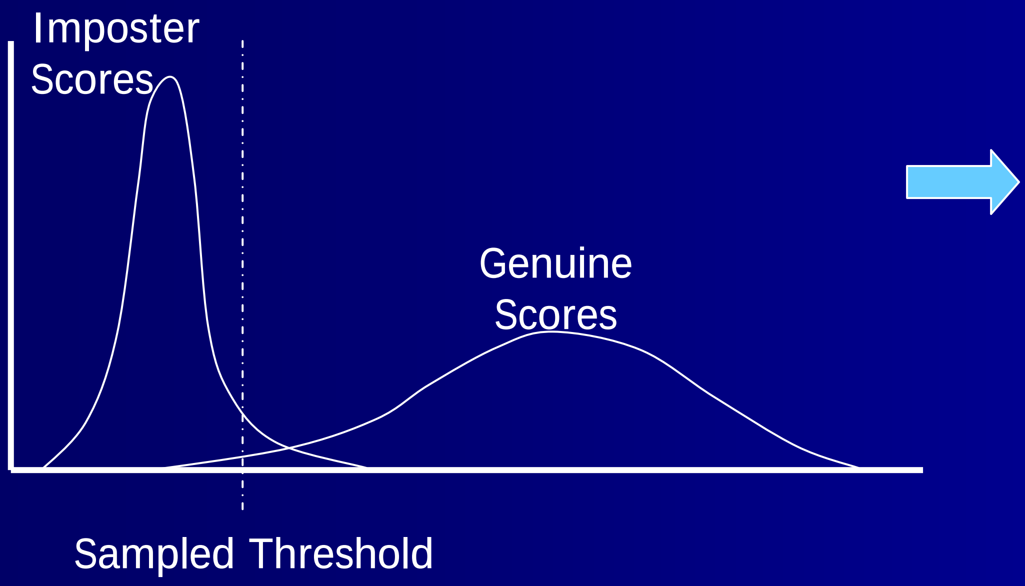
SDK Encoder

Machine Tenprint Features

Back End Metrics

Score Based

(Many 1-to-1 matches)



Imposter Scores

Genuine Scores

Sampled Threshold

ROC or DET Curve

Back End Metrics

Rank Based

(Many 1-to-1 matches)

E.g. Is the latent's mate returned in the list of "high-probability" candidates?

What rank-based statistics apply?

Percentage of time mate shows up within top-N candidates?

Rank based statistics require a gallery of significant size

Score Normalization

The Issue

- Match score is likely to be dependent on characteristics such as the number of true minutiae in the latent, and the number of true minutiae varies greatly between latents

- Latent match scores may need to be normalized so that they can be compared using score-based metrics

Score Normalization

SDK Subroutine:

- IN: Vector of Scores

  (E.g. All scores for latent against gallery of tenprints)
- OUT: Normalized Vector of Scores

Gallery Selection

Possibilities:

1. Select a general gallery and search with all latent probes
2. Select a gallery dependent upon the finger position of each latent probe
3. Select a gallery with fingerprints that most likely match the latent's mate

Testing Data
(Format)

Images:

Tenprint	A/N Type-4&14; WSQ
Latent	A/N Type-13; UNCOMP

Feature Templates:

Human	A/N IAFIS Type-9
Machine	A/N IAFIS Type-9 & Proprietary

Pre-Test Demonstration (Leveraging SD27)

Latent Search Grand Challenge?

- Host an ‘open’ forum to determine feasibility of latent SDK testing

Qualify latent SDK test participants

- Determine fundamental abilities of a participant to implement the testing protocol

Latent SDK Test Assumptions

- The test protocol must be entirely automated
- Participants must provide both an Encoder and a Matcher
- Performance will be measured in terms of match determination ability
- Similarity scores must be comparable across independent latent searches (normalization may be required)

Latent SDK Test Assumptions
(Cont)

- Submitted encoders will be required to compute at a rate less than some maximum amount of time
- Submitted matchers will be required to match at a rate less than some maximum amount of time

Anticipated Performance

Analyses should focus on what level?

- FMR @ 0.5, 0.1, 0.01, ...?
- FNMR @ 0.5, 0.1, 0.01, ...?

These anticipated error rates

- Help determine data set sizes
- Help determine time and resource allocations

Data Questions

How many latents?

- 300, 1000, other?

How many tenprints?

- 1000, other?

Criteria for sample selection of tenprints?

- Pattern class distribution?

Is there AFIS-matcher bias in the data?

- How were mates determined?

Possible Speed Constraints

Given size of proposed tests ...

Machine encode within 5 sec.

- Latent encoding may be slower than tenprint encoding

Match determination within 1-5 sec.

- What can you do?

Summary

- Proposed a framework for the automated SDK testing of latent algorithms
  - How good is machine encoding?
  - Benefits of machine encoding?
  - How good is automated match determination?
  - Benefits of automated match determination?
- Front End
  - Human, Machine, & Hybrid Latent Feature Sets
- Back End
  - Latent-to-tenprint and tenprint-to-latent
  - Score and rank based metrics
- SDK Subroutines
  - Encoder, Matcher, & Score Normalization

Conclusion

Things we need:

- Your feedback and suggestions
- Your level of interest to participate in latent SDK tests
- Your ability to share imagery of solved latent cases with NIST